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IS 11348 (1989): Iron ore pellets - Apparent specific gravity, true specific gravity and porosity - Method for determination apparent [MTD 13: Ores and Raw Materials]



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Indian Standard

**IRON ORE PELLETS — APPARENT SPECIFIC
GRAVITY, TRUE SPECIFIC GRAVITY AND
APPARENT POROSITY — METHODS FOR
DETERMINATION**

(First Revision)

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on 30 August 1989, after the draft finalized by the Ores and Raw Materials Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1985. Keeping in view of the recent developments in the field, it was felt necessary to revise this standard. In this revision, the method for determination of true specific gravity has been incorporated to calculate the apparent porosity, which is more relevant characteristic of the pellets for blast furnace feed.

In assessing the quality of blast furnace burden, the conditions are being laid down to ensure requisite characteristics in the quality of raw materials. Apparent specific gravity, true specific gravity and apparent porosity of iron ore pellets are the important characteristics and this standard rationalizes the methods used for determining apparent specific gravity, true specific gravity and apparent porosity of iron ore pellets.

While preparing this standard, assistance has been derived from JIS M 8716 : 1971 'Methods for measuring the apparent specific gravity and the porosity of iron ore pellets', issued by the Japanese Industrial Standard Committee.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

IRON ORE PELLETS — APPARENT SPECIFIC GRAVITY, TRUE SPECIFIC GRAVITY AND APPARENT POROSITY — METHODS FOR DETERMINATION

(*First Revision*)

1 SCOPE

1.1 This standard covers the method for determination of apparent specific gravity, true specific gravity and the method for calculating the apparent porosity of iron ore pellets.

2 REFERENCES

2.1 The Indian Standards listed below are necessary adjuncts to this standard:

<i>IS No.</i>	<i>Title</i>
IS 460	Test sieves : Part 1 Wire cloth (Part 1) : 1985 test sieves (<i>third revision</i>)
IS 9101 : 1979	Methods of sampling iron ore pellets

3 METHOD FOR DETERMINATION OF APPARENT SPECIFIC GRAVITY

3.1 Outline

The volume of individual iron ore pellets from the physical test sample drawn for the purpose are measured by immersing them in mercury using a specified testing apparatus. The masses of individual pellets are also obtained by weighing on a balance. The ratio of the mass of the sample to the volume of sample is expressed as the apparent specific gravity.

3.2 Sample

Whole and crack-free pellets drawn from the sample, dried at $105 \pm 5^\circ\text{C}$ to constant mass are used for the test. The sample for this test shall be drawn as per IS 9101 : 1979 and further processed as indicated in Annex A. The number of pellets as per test shall be not less than 12, of size between 9 and 16 mm.

3.3 Apparatus

- a) *Volume Measuring Apparatus* — A typical apparatus for measuring the volume of the sample is shown in Fig. 1, with respect to the balance system, the part which is to be immersed in the mercury shall be given such a surface which may not alloy with the mercury.

The float of the system shall be made of a material which has a specific gravity, slightly less than the apparent specific gravity of the pellets. The depth of the mercury vessel shall be about 150 mm. The minimum unit of the balance weights being used shall be 0.01 g.

NOTE — The balance system consists of the Parts 1, 2, 3, 4, 6, 7, 8, 11 and 12 as shown in Fig. 1.

- b) *Drying Oven* — The oven shall be capable of regulating the temperature at $105 \pm 5^\circ\text{C}$.
- c) *Weighing Device*, it shall be sensitive to 0.01 g or less.
- d) *Thermometer* — The minimum graduation of the thermometer shall be 0.5°C or less.

3.4 Procedure

The test shall be carried out in accordance with the following procedure:

- a) Weigh each pellet separately (*M*).
- b) Immerse the sample holder of the balance system into the mercury. Place the weights on the weight pan until both the needle tips touch the surface of mercury simultaneously. Push the balance rod gently by finger downwards, and leave it. When the unit is stabilized, ensure that both the needle tips (simultaneously) touch the surface of mercury as in the initial trial. If the needle tips do not return to the initial position, adjust again the masses and the adjusting screws and repeat the same procedure until the needle tips touch the surface of mercury, simultaneously.
- c) Gently lift the balance system from the surface of mercury. Insert each pellet inside the sample holder and repeat the procedure in (b) above and record the amount of added mass (*m*).
- d) Measure the temperature of the mercury in the mercury vessel and record the specific gravity of mercury at the testing temperature.

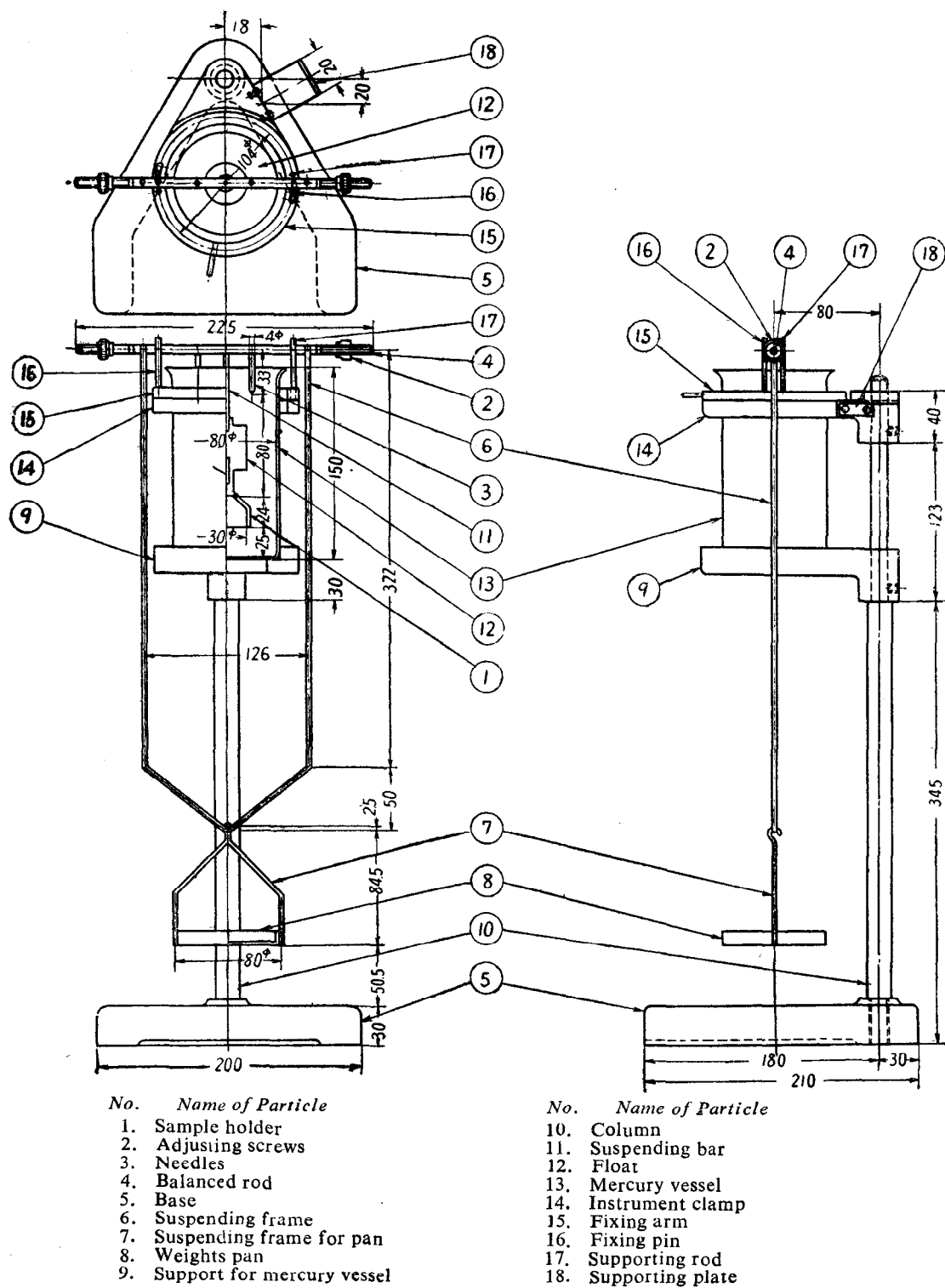


FIG. 1 AN EXAMPLE OF APPARATUS FOR MEASURING THE VOLUME OF PELLET

3.5 Calculation

The apparent specific gravity shall be calculated from the formula given below:

$$S_A = \frac{M}{M + m} \times S_{Hg}$$

where

S_A = apparent specific gravity,
 M = mass in g of the pellet,
 m = mass in g of the balance weights applied at the time of testing in 3.4(c) above, and

S_{Hg} = specific gravity of mercury
at the temperature of the
test.

3.6 Number of Tests

The test shall be carried out in duplicate. If the difference between the pair of tests exceeds tolerance limit of 0.04, further duplicate test shall be made. Accept the mean of these duplicate tests if the difference between two tests does not exceed 0.04. If the second test also exceeds the tolerance limit, then report the results of all four tests.

3.7 Expression of Result

The apparent specific gravity shall be expressed by the mean value of either a pair of results of duplicate tests conforming to the tolerance limit or of four results of two duplicate tests. The result shall be rounded to second decimal place.

4 METHOD FOR DETERMINATION OF TRUE SPECIFIC GRAVITY

4.1 Sample

Out of the 5 000 g sample of iron ore pellets obtained for the specific gravity test, as given in Annex A, obtain about 100 g of representative sample. Dry the sample in an air oven at $105 \pm 5^\circ\text{C}$ to constant mass. Crush and pulverise this entire sample to pass through a 45-micrometer sieve.

4.2 Apparatus

- Specific gravity (sp gr) bottle of volume of 50 ml.
- Drying Oven, capable of maintaining a temperature of 105°C .
- Constant temperature water bath capable of being maintained at a temperature of $20 \pm 1^\circ\text{C}$.
- Balance, an analytical balance having sensitivity of 0.001 g.
- Woven, wire sieve of 45 micrometres as specified in IS 460 (Part 1) : 1985.
- Desiccator.
- Benzene, benzol, xylene or toluene (Analytical grade chemicals).

4.3 Procedure

The test shall be carried out in accordance with the following procedure:

- Find the mass of the empty specific gravity bottle with stopper (M_1).
- Weigh out the sample of about 20 g previously dried at $105 \pm 5^\circ\text{C}$ for at least two hours and cool in a desiccator.
- Transfer the sample gently into the empty specific gravity bottle and weigh it with stopper (M_2).
- Remove the stopper, add sufficient benzene to cover the sample. Shake gently the specific gravity bottle until there are

no more air bubbles from the sample, and boil it in a water bath by applying suction through a standard water tap for 20 minutes.

- Remove the specific gravity bottle, fill the benzene up to the calibration mark. Put the stopper and cool to 20°C by immersing in a constant temperature water bath, maintained at $20 \pm 1^\circ\text{C}$, for 60 minutes, and align the surface of benzene to the mark.
- Remove the specific gravity bottle from the constant temperature bath, wipe off the adhering water, cool to the ambient temperature and weigh (M_3).
- Empty the bottle completely, wash thoroughly, rinse it with benzene, and fill it up with fresh benzene up to the mark, put the stopper and weigh (M_4).

4.4 Calculation

True specific gravity S_2 , shall be calculated by the following formula, to the third decimal place:

$$S_2 = \frac{(M_2 - M_1) \times \text{sp gr of benzene at } 20^\circ\text{C}}{(M_4 - M_1) - (M_3 - M_2)}$$

where

- S_2 = true specific gravity,
 M_1 = mass in g of sp gr bottle together with stopper,
 M_2 = mass in g of sp gr bottle with stopper containing the sample,
 M_3 = mass in g of sp gr bottle with stopper containing the sample and filled with benzene, and
 M_4 = mass in g of sp gr bottle with stopper filled with benzene.

NOTES

1 Benzol, xylene or toluene may also be used in place of benzene.

2 In case the true density is required, use the value of density of benzene at 20°C in place of specific gravity of benzene in the above formula.

4.5 Number of Tests

The test shall be carried out in duplicate. Accept the results, if the difference between the two values falls within permissible tolerance as given in 4.6. If the difference between the pair of test results exceeds the permissible tolerance given in 4.6, a further duplicate test shall be made. Accept the second pair of test results if they meet the permissible tolerance. If the second test results do not, again, meet the permissible tolerance, accept all the four test results.

4.6 Permissible Tolerance

In the case of the same laboratory, same testing apparatus and the same operator, the difference between a pair of results of a duplicate test shall be 0.03 or under.

4.7 Expression of Result

The true specific gravity shall be expressed by the mean value of either a pair of results of a duplicate test conforming to the tolerance limit or mean of four results of two duplicate tests, by rounding off to the second decimal place.

by the following equation. Result shall be rounded to the first place of decimal:

$$P = \frac{S - S_A}{S} \times 100$$

where

P = porosity in percent,

S_A = apparent specific gravity, and

S = specific gravity of the sample.

5 METHOD OF CALCULATING THE APPARENT POROSITY

5.1 The apparent porosity shall be calculated

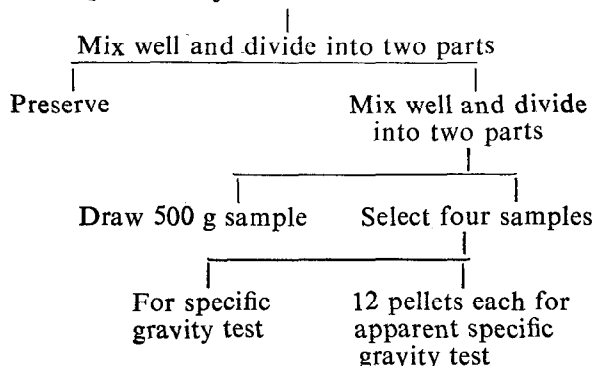
ANNEX A (Clauses 3.2 and 4.1)

SAMPLE PREPARATION

5 kg sample from physical test sample collected and prepared according to IS 9101 : 1979.

Screen on 9 and 16 mm sieves and use that fraction of sample, between 9 and 16 mm size, for further tests.

Select only whole and uncracked pellets. Reject the rest.



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Doc : No. MTD 13 (3435)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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